Implementing Technology to Drive Profitability

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Novozymes Technical Service
Today’s discussion

1. Novozymes: biological solutions

2. Improving plant efficiency through data analytics and technical service

3. New liquefaction technologies drive plant profitability
Introducing nature's problem solvers

Sometimes the greatest answers in life are found in its smallest components

Enzymes

Microorganisms

Catalyzing processes and building up or breaking down molecules

Cleaner clothes with less consumption of energy

Better nutrition with less food waste

Green fuel to reduce our dependence on oil

Higher yields and fewer pesticides

We also work with other proteins, biopolymers and related technologies
Biofuels Technical Service: As your implementation experts, we bring innovation to the industry

- The largest team in the industry
  44 dedicated experts ready to help you
- Guided by in-depth knowledge
  19 advanced degrees on the team
- Seasoned implementation experts
  259 years of collective experience in the ethanol industry
- On the ground with you
  12,000 hours spent on site each year
- Turning data into solid business decisions for you
  1 billion data points analyzed each year
- Unrivalled fermentation expertise
  100,000 fermenters analyzed each year
Service areas focused on your needs

- Laboratory
- Products
- Process
- Data
- Training
Data: Golden Batch

Golden Batch provides you with answers to these questions and more:

- What can I do to improve plant performance and cost efficiency at little to no extra input cost?
- How do I translate all my plant’s performance data into actionable improvements?
Bioenergy University provides access to a specialized collection of training courses for plant employees to continuously advance their skills and knowledge:

- Build deeper process and product understanding
- Increase awareness of plant processes and procedures
- Develop and refine plant best practices
- Improve process consistency
The bioenergy winners of tomorrow will be those who stay agile and keep moving forward.
Keys to success

1. Increased production efficiency
2. Cost savings
3. Process consistency
4. Diversification with higher value streams
Novozymes’ solutions are the small components which make a big difference when margins matter.

We have to have the broadest, highest-performing toolbox and full value package in the industry for all types of plants and market conditions.

Our technical service team stands by your side to innovate, implement solutions and bring you new value. Be it DDGS, yield enhancement or energy savings, our solutions keep you advancing.
Novozymes Technical Service and Research & Development teams work collaboratively toward new, meaningful solutions

**NEED:** Industry needs to continuously innovate to remain competitive

- Customer ideation sessions to identify trends & pain points
- Collection of representative data & samples from the plants
- Screening for new enzyme solutions
- Upscaling and conducting of field trials
- Understanding of benefits & limitations
- Apply learnings to help develop new customer-focused ideas

*Image of a circular process diagram with steps.*
Squeezing the last drop out of every kernel and market condition

- Starch
  - GA
  - AA
    - cellulases
    - proteases
    - yeast
    - ?
- Protein
- Fiber
- Oil
A broad toolbox that helps you stay agile and flexible

Glucoamylases

Spirizyme Ultra XHS
Spirizyme Excel Plus
Spirizyme Achieve

Price
Performance

Alpha-amylases

Liquozyme LpH
Avantec HS
Avantec Amp

Price
Performance

Glucoamylases

Spirizyme Ultra XHS
Spirizyme Excel Plus
Spirizyme Achieve

Price
Performance

Alpha-amylases

Liquozyme LpH
Avantec HS
Avantec Amp

Price
Performance
Introducing Liquozyme LpH
A new low pH alpha-amylase

Benefits
• Superior viscosity reduction at low pH ensures smooth operational performance
• Peace of mind with industry-proven robust performance to insure against pH excursions
• Enables reduction or elimination of ammonia to help reduce risk to your plant
• Formulation and performance provide an economical enzyme choice you can trust
Liquozyme® LpH
Eases and improves operational efficiency

Viscosity (185 °F, 150 min liquefaction)

Dextrose Equivalent (DE) (150 min liquefaction)

All trials run at pH 5.2
Introducing Avantec® Amp
The industry’s most advanced liquefaction product
**Spotlight on Avantec® Amp: An new industry standard**

**MORE**
- Faster, more consistent and robust fermentations +
- Increase ethanol yield +
- Safer work conditions and process simplicity +
- Capacity to run higher solids or increase throughput +

**LESS**
- Less process inputs of urea, ammonia, corn-oil surfactants
- Eliminate stand-alone protease storage, addition and cost
- Less storage and handling of chemicals
- Less complexity - simplify the recipe by eliminating process additions to reduce the risk of errors
- Less process upsets due to enhanced viscosity performance

15% or more corn oil yield + 70-90% less nitrogen = More net profits
Set a new standard:

Reduced spend on urea

Typically more than

$700,000/year

for a 110 MGY plant

Calculation based on:

• Estimated reduction of 3,000 pounds urea per fermentor
• Reduction of 1,620 tons of urea per year at $450/ton
• That’s elimination of over 3,200 sacks per year, each with 1,000 pounds urea
Set a new standard: 
**Amp up your fermentation health**

Fermentations become much more uniform as Avantec® Amp provides the yeast with a continuous nitrogen source of amino acids and peptides, and also achieves robust starch conversion. Avantec® Amp offers excellent viscosity reduction in cook.

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<tr>
<th>Avantec Amp:</th>
<th>What it means for your plant</th>
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<td>• Excellent reduction of viscosity of mash at a wide pH profile</td>
<td>Gives you the choice to run at higher solids or higher run rates</td>
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<td>• Much more uniform fermentations, due to consistent N feed and quality to yeast</td>
<td>Value for a 110 MGY plant:</td>
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<td>• Lower glycerol profile</td>
<td>1% ethanol yield ≈ $250,000 net profit</td>
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<td>1% throughput gain ≈ $300,000 net profit</td>
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Set a new standard: 
“provides generous value for ethanol plants to capture”

“Avantec® Amp provided us with significant increased production of corn oil, and also substantial reductions in fermentation ingredient inputs. This, coupled with ethanol yield improvements, provides generous value for ethanol plants to capture.”

Dan Sanders Jr, Vice President, Front Range Energy, Windsor, Colorado
Together, we create **new value**. We deliver on **this promise** for all types of plants and market conditions.

- Throughput, yield and energy **performance** to increase your margins
- Access to new, industry-leading **innovation** to keep you advancing
- Continuous **training** to keep your people safe and up-to-date
- **Data insight** and **benchmarking** for enhanced decision-making
- On-site **implementation taskforce** to help ensure results
novozymes®
Rethink Tomorrow